

Sub-sectoral study series: Volume 01

Cereals: Rice



Bangladesh Agricultural Research Council
New Airport Road, Farmgate, Dhaka -1215



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Foreword

Documents on agricultural sub-sector covering all areas under its broader purview are important for the policy makers, researchers and development actors of agricultural research and development (R&D). Realizing the need, Bangladesh Agricultural Research Council, as did in the past, initiated this present activity in the later part of 2009 for conducting detailed sub-sectoral studies in agriculture. The purpose was to generate background information covering areas of priority research and finally to step forward towards the development of the Agricultural Research Vision-2030 and Beyond document.

For the purpose, the agricultural sub-sector was divided as (1) Rice, (2) Non-Rice Cereals, Sugarcane and Jute (3) Horticultural Crops: Fruits, Vegetables, Spices, Flowers and Potato (4) Pulses and Oil crops (5) Land and Soil Resources Management (6) Forestry (7) Livestock (8) Fisheries (9) Irrigation and Water Management, Farm Machinery, and Post-harvest Technology (Engineering Aspects) (10) ICT and Disaster Management in Agriculture (11) Agricultural Economics, Marketing and Supply Chain Development and (12) Human Nutrition: Food Availability and Safety, Agro-processing and Post-harvest Loss. In doing so, BARC selected twelve experts of repute in the area with proven contribution in the field as the Group Leader with counterpart scientist from the council.

These 12 sub-sectoral study reports are the outcome of in-depth review of various documents related to agriculture and rural development, especially the Planning Commission reports and Five Year Plans, Poverty Reduction Strategy of the government along with MDG, different national policy reports on agriculture, food, land use, livestock, fisheries and forestry, Vision document 2020 of BARC, Food security, quality and safety materials and available agricultural reports of WB, FAO, DFID, DANIDA and other development partners etc. In addition, series of consultations with knowledgeable quarters were made at the respective group level and at the regional and national workshops. Through review and analysis, the problems, potentials and the gap between the country's need and the present reality were identified and subsequently came up with the priority research need to address those issues.

It is to be appreciated that the agricultural research priorities have been prepared under the present socio-economic context and environmental understanding. However, with change in the situation over time and space further revision of the document would be needed. The scope and opportunities exists for gradual improvement of the priorities as we proceed to work with the suggested research priorities, gain knowledge and face new challenges.

We have now 12 supporting sub-sectoral documents on agriculture to facilitate preparation of the Vision-2030 and Beyond document as well to undertake priority research under different themes through institutional support and for problem-solving research under SPGR and CGP to generate demand-led technology. BARC feels extremely encouraged to be able to publish these sub-sectoral documents in agriculture for circulation among the NARS institutions, Universities and development partners and various other stakeholders.

As obvious, it took quite sometime to reach at this stage. But now, it appears to be worth as finally we could come up with the twelve volumes of the agricultural sub-sectoral study. These documents are to serve as a guide for undertaking future research programs and to provide direction in building the required research capacity and infrastructure of the NARS. The journey was long and the process is laborious. Identifying the best available persons to do the job, deciding on our need, providing the required guidelines, formation of technical groups within each area, getting feedback from the research, extension, input suppliers and marketing agencies, gathering problems and analyzing their magnitude and beneficiaries along with research need, organizing four regional workshops at the division level; (attended by all relevant stakeholders including farmers), presentation of the draft in different forums and finally to get the response of the participants of the 3-day national workshops all were the part of activities needed to be performed. Mr. M. Anwar Iqbal, M&E Expert of the PIU-BARC was instrumental in the whole process-from the very conceptualization to the development of these 12 sub-sectoral reports and publications. Particular thanks are due to him for his invaluable contribution. Dr. Sk. Ghulam Hussain, Member-Director (P&E) took all the pain to provide necessary guidance, making presentations at the highest level, performing as the convenor of the priority finalization committee. Dr. Paresh

Chandra Golder, CSO (P&E) coordinated the activities with utmost diligence. Much thanks are due to them. PIU-BARC and the Krishi Gobeshona Foundation (KGF) deserve special thanks for their conscientious support required to undertake the task and in organizing the workshops.

BARC expresses its heartfelt thanks and gratitude to all the group leaders, counterpart scientists of BARC, expert members of the teams and to the participants of the workshops. BARC hopes that research scientists of the NARS, extension agencies, development partners and relevant others would find these documents useful to take up agricultural R&D in order to cope with the priority and addressing emerging needs.

Dr. Wais Kabir

Executive Chairman, BARC

Contents

Foreword	i
Contents	iv
Acknowledgement	vi
Abbreviations	vii
Executive Summary	viii
1.0 Introduction	1
2.0 Methodology and Approaches	2
3.0 Reviews: Rice Areas, Production, Yield Trends and Requirements	4
3.1 Trends of Rice Production and Population Growth	4
3.2 Rice Eco/culture Types and MV Adoption	6
4.0 Rice Research Progress	7
4.1 Varietal Development with Emphasis on Hybrid Rice and Biotechnology	7
4.2 Diseases and Insect-Pests Management	9
4.3 Crop Adaptation to Climate Change and Coastal Agriculture	10
4.4 Drought Management	12
4.5 Yield Gap and Yield Loss in Rice Production	14
4.6 Hill Rice and Agriculture	16
5.0 National and International Co-operation in Rice Research	18
6.0 Field Problems and their Ranking	19
7.0 Comments/Suggestions of Workshop Participants	20
8.0 Conclusion and Recommendations	20
9.0 Research Priorities	24
9.1 Research Agenda/Thematic Areas	24
10.0 Five Years Research Plan (2010-2015)	26
10.1 Bangladesh Rice Research Institute (BRRI)	26
10.2 Bangladesh Institute of Nuclear Agriculture (BINA)	32
10.3 Bangabandhu Sheikh Mujibur Rahman Agricultural University: Department of Genetics and Plant Breeding	33
References	35
 Annexure	
I Terms of Reference (TOR) of the Group Leader	37
II Group Work Guidelines	39
III List of Group Leaders and Member-Secretaries and areas to be covered (but not limited to)	40
IV List of Participants in Group Workshops	43
V Comments on the draft report by the experts in a workshop held on 8th March 2010 at BARC	44
VI Workshop on Problem Identification and Priority Setting	49

List of Tables

1	Area, production and yield trends of rice in Bangladesh, 1970-2006	4
2	Changes in rice area under four seasons 1970-2006	5
3	Projected population, population growth rate, land man ratio and demand and yield of rice, 1995-2020	5
4	Seasons, Eco/culture type, Area, MV area and Yield of different ecotypes in Bangladesh, 2005-06	6
5	Rice Area (ha) in four coastal regions of Bangladesh during 2005	10
6	Rice Area (ha) in three hill districts of Bangladesh during the year 2005	11
7	Salt affected areas under different salinity categories in the coastal district of Bangladesh	11
8	Apparent nutrient balance sheet for three rice crops per year over eight years, BRRI, Bangladesh, 1984-91	11
9	Intensity of drought and yield reduction of broad cast Aus and T. Aman rice in Bangladesh	13
10	The farmers' experience with rice yield by culture and by season (kg/ha)	15
11	Yield gap and yield loss from various stresses, estimates from farmers perception	15
12	Summary of field problems and their ranking in four regions	19

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The Group Leader is also thankful to all the stakeholders who contributed to identify field problems on rice in four regional workshops at Bogra, Chittagong, Barisal and Mymensingh. Finally, time to time advice and logistic support provided by P&E, BARC, Dr. Mian Sayeed Hassan, PSO (Crops), BARC and Mr. Babur Ali for help with computer compose in preparation of the report are gratefully acknowledged.

Dr. Nasiruddin

Abbreviations and Acronyms

ATC	: Agricultural Technical Committee
BARC	: Bangladesh Agricultural Research Council
BARD	: Bangladesh Academy for Rural development
BINA	: Bangladesh Institute of Nuclear Agricultural
BPH	: Brown Plant Hopper
BRRRI	: Bangladesh Rice Research Institute
BSMRAU	: Bangabandhu Sheikh Majibur Rahman Agricultural University
CGIAR	: Consultative Group on International Agricultural Resarch
CMS	: Cytoplasmic Male Sterility
DAE	: Department of Agricultural Extension
DANIDA	: Danish Development Agency
DFID	: Department of International Development
DNA	: Deoxyribonucleic acid
DoE	: Department of Environment
FAO	: Food and Agriculture Organization
GDP	: Gross Domestic Product
GHG	: Green House Gas
GIS	: Geological Information System
GLH	: Green Leaf Hopper
GO	: Government Organization
HYV	: High Yielding Variety
ICT	: Information and Communication Technology
IPCC	: Intergovernmental Panel on Climate Change
KIT	: Knowledge Intensive Technology
LDC	: Least Developed Country
MAS	: Marker Assisted Selection
MDG	: Millennium Development Goal
MV	: Modern Variety
NARS	: National Agricultural Research System
NGO	: Non-Governmental Organization
P&E	: Planning and Evaluation
PCR	: Polymerase Chain Reaction
PIU	: Project Implementation Unit
QTL	: Quantitative Trait Loci
R&D	: Research and Development
RCBD	: Randomized Complete Block Design
RTV	: Rice Tungro Virus
SCA	: Seed Certification Agency
SLR	: Sea Level Rise
SSR	: Simple Sequence Repeat
SWOT	: Strength, Weakness, Opportunity and Threat
ToR	: Terms of References
USA	: United States of America
USG	: Urea Supper Granule
WB	: World Bank
WBPH	: White Brown Plant Hopper

Executive Summary

The past, present and future status of rice production, yield, MV coverage, research and constraints are briefly summarized below:

Two approaches were followed to prepare the report on priorities of rice research vision 2030 and beyond. Firstly, information on the trends of rice area, production, yield, MV coverage, coastal and hill rice, salinity and drought situations etc. were collected from the BBS and other published reports. Secondly, 4 regional workshops were organized by BARC and KGF to identify field problems. The recommendations of HYV rice workshops between BRRI-DAE from 1996 to 2004 were also considered. Finally, the priority research agenda was prepared through three group workshop held at BRRI and BARC with the NARS scientists, especially BRRI.

The total rice area is estimated 10.58 Mha, production 27.31 Mt, yield 2.58 t/ha, MV yield 3.14 t/ha and MV coverage 74% during 2006-07 (BBS). The highest MV area (96%) is in Boro, followed by 65% area in T. Aman, 50% in T. Aus.

The rice accounts for 94% of food grain production. More than 90% of the population derives 76% of its daily calories and 66% of its protein needs from rice. Rice alone contributes.

By the year 2030, the population will be about 195.53 million requiring 39.8 million t. of rice, keeping the area more or less constant, the required total yield would have to be 3.8 t/ha, but the present yield is only 2.58 t/ha.

The total area, total yield, production and MV coverage are somewhat explained by breaking the total figures into seven culture/ecotype. The boro season is divided into two boro inland and boro tidal wetland saline. The aus season is divided into three, direct seeded, transplanted and tidal wet land saline. The T.Aman season is divided into T. Aman inland and T. Aman tidal wetland weakly saline, and the deep water rice.

The area, MV yield, the varietal characteristics, problems/constraints and opportunities for improvement are also different for different culture/ecotype. The boro yield is 3.4 t/ha and the deep water rice

yield is only 1.17 t/ha and the rests culture/ecotype yields are in between.

Out of the 2.2 Mha of the gross cropped area in the coastal region, the rice area is 81% varying from 79% in Barisal, Noakhali and 85% in Khulna. But the MV coverage is 6% in Aus, 14% in T. Aman and 20% in Boro against the national coverage of 74%. Salinity and submergence due to flooding is the limiting factor for the expansion of MV rice area in the coastal region.

There are 0.224 Mha of gross cropped area in the three hill districts. The rice covers 54% of the cropped area. The MV coverage is 11%, 26% and 35% in Aus, Boro and T. Aman seasons respectively.

Total salt affected area in the five coastal regions is about 35% having the lowest 13% in Barisal and the highest 70% in Khulna.

The cropping intensity is about 180% which may be the highest in the world. To meet the future demand of food, cropping intensity and yield of rice must have to be increased causing nutrients depletion, a challenge to meet the yield demand by 2030.

Besides, natural resource degradation due to erosion, salinisation, organic matter depletion, water logging, pan formation, acidification and deforestation, yield reduction due to drought occurs in Aus and T. Aman seasons considerably. Though, the Aus area decreased by about 50% from the year 1990 to 2006 but the T. Aman area is more or less static signifying the importance of drought in T. Aman season.

1.0 Introduction

Bangladesh has a total area of 14.4 million ha, 57% of which are arable. It is one of the densely populated countries of the world with 1088 persons/km² (2008-09). Agriculture is the backbone of the economy accounting for 20.83% of GDP and 48.40% of employment. More than 90% of the population derives 76% of its daily calories and 66% of its proteins needs from rice.

Based on National Agricultural Policy, a three year (2007-08 to 2009-10) Action Plan to increase rice production by 17-25% was prepared by a Technical Task Force Constituted by the Ministry of Agriculture. The Task Force determined the population as 147.52 million (1.48 % growth rate) and the requirements of rice as 24.827 million tonnes against the production target of gross 34.88 Mt at the end of the year 2009-10. The Action Plan is under implementation at present.

Rice research and production system has undergone immense change during 1970-71 to 2006-07 (Table 1). Though, the total rice area remained more or less static around 10.5 Mha during the period but the production increased by 2.58 times. Still food security has been and will remain a major concern for Bangladesh, because of continued population growth at relatively high rate. By 2020 and 2030 the population will be 170.91 and 195.53 million requiring 35.5 and about 40.0 million tonnes rice respectively.

This is a monumental task, because the cropping intensity in Bangladesh has already reached 180%, perhaps the highest in the world. Further more, agricultural land is increasingly diverted to other uses such as housing, roads and industrial development. To be sustainable, future production must be achieved with less land, less labour and less water with no harm to the natural environment. Against this background, the challenge for Bangladesh is great and only the application of modern technology, appropriate strategies, planning and implementation will lead to success. In this regard, BARC is planning to prepare priorities of Rice Research Vision Document 2030 and beyond. In this report, rice production, yield trends, rice cropping intensity and constraints of rice production are reviewed and priorities of rice research are prepared.

2.0 Methodology and Approaches

Based on the Terms of References (ToR) and the Guidelines for Group Works, the group leader and the member secretary for rice initiated information gathering and discussion with relevant personnel of NARS for rice. Under rice, following areas are included for the Vision Document 2030. These are (i) improvement of rice varieties (ii) disease and pest management, (iii) crop adaptation to climate change, (iv) biotechnology, (v) coastal agriculture and (vi) drought management. However, in order to avoid possible duplication/overlapping and present programme area approach of rice research at BRRI, the national institute for rice, rice varietal improvement and biotechnology, crop adaptation to climate change and coastal agriculture were considered together. In addition, as per mandate of BRRI, crop-soil-water management, post harvest technology, rice farming system, socio-economics and policy are included under rice.

The group leader and the member secretary first organized a workshop with the programme leaders and Head of all Divisions at BRRI. The group leader explained to the members of the workshop; BARC efforts and aims of preparing a sectoral research vision document 2030 and beyond. In this context, the group leader explained the role of rice in the national economy, the responsibility and challenge of the rice scientists to meet the food requirements of the country during the vision period and beyond. At this, one of the programme leaders responded that we can achieve food requirement upto 2020 by adopting present rice technologies, minimising 50% yield gap, solving some field problems, especially drought, etc.

During discussion, some heads of division pointed out that for some divisions, preparation of long term research programme for 20 years or so, may be difficult and not realistic. So, it was decided that each research division under their respective programme area, will prepare a 5 year perspective research plan towards vision 2030. On the basis of 5 year plan, through modification, changes etc., they will reach the target up to 2030. It was decided that each division will prepare a 5 year research plan under the respective programme areas and submit in the 2nd workshop for discussion. It was also decided that for rice varietal development, Bangladesh Institute of Nuclear Agriculture (BINA) at Mymensingh and for hybrid rice, plant breeding department of Bangabandhu Sheikh Mujibor Rahman

Agricultural University (BSMRAU) at Salna, Gazipur may be included.

Second group workshop was held at BARC with seven programme leaders of BRRI and leader of hybrid rice project of BSMRAU. There was no representation from BINA. In the workshop, there were about 120 research proposals from 18 divisions of BRRI under seven programme areas and hybrid rice research proposal for Boro and T.Aman seasons of BSMRAU. Group leader briefly presented the past status of rice production in respect of changes of acreage in four seasons, areas under MVs, total yield of MVs. He also projected population trends, demand for rice, and the required yield t/ha of rice between the years 1995-2030. It was decided that group leader will prepare a short list of priority research agenda based on the present situation and future requirements of the country and present the short list in the next workshop for finalization.

Third group workshop was held at BARC with seven programme leaders and representative of BINA. Group leader presented the short list of research agenda and after discussion, some changes and modification it was finalized. The group discussion outcome was shown in Annexure-I.

Regarding identification of field problems and formulation of short listing of research proposals from different NARS organizations, group leader studied the recommendations of BRRI-DAE workshops on MV rice cultivation during the years 1996 to 2006. In addition, four regional stakeholder workshops were organized by BARC and KGF at Bogra, Chittagong, Barisal and Mymensingh to collect information on field problems for rice research. Action Plans, different BRRI's reports and group leader's own experiences are taken into account.

As regards total rice area, areas under MVs, changes of areas under four seasons, total yield, yield of MVs, trends of production, yield, demand for rice by the year 2030 are taken from BBS sources.

3.0 Review: Rice Areas, Production, Yield Trends and Requirements

3.1 Trend of Rice Production and Population Growth

Rice, the staple food crop of Bangladesh, covers about 10.58 million ha of cropped area and accounts for 94% of food grain production. More than 90% of the population derives 76% of its daily calories and 66% of its protein needs from rice.

Bangladesh made modest but steady progress in agriculture in the post independence period from 1970-71 to 2006-07 when cropping intensity increased from 148% to 180% and rice production more than doubled (Table 1). As the dominant crop, rice largely determines the rate of progress in the agriculture sector. In fact, the entire growth in crop production is explained by the growth in food crop production, particularly, rice.

During the last three decades, the area grown under rice remained more or less static, but the total production and yield of rice were doubled (Table 1). The replacement of traditional varieties by MVs caused the increase in rice production and yield (Table 1). The expansion of irrigated area during the boro season and use of fertilizers contributed to higher rice production. The Aus and deep water rice areas decreased over the last three decades, while the transplant Aman (T.Aman) areas remained more or less the same (Table 2).

Table 1. Area production and yield trends of rice in Bangladesh, 1970-2006

Year	Area (Mha)	Production (Mt)	Yield (t/ha)		MV rice area (%)
			Total	MV	
1970-71	9.74	10.97	1.1	3.3	4.7
1980-81	10.30	13.88	1.3	2.3	21
1990-91	10.40	16.79	1.6	2.1	44
2000-01	10.80	25.08	2.32	2.67	70
2006-07	10.58	27.31	2.58	3.14	74

Source: BBS (2008) and FPMU

Table 2. Changes in rice area under four seasons 1970-2006

Year	Area (million ha)				Total (Mha)
	Boro (irrigated)	Aus	Deep water rice	T.Aman (rainfed, medium high land)	
1970-71	0.80	3.19	1.82	3.91	9.72
1980-81	1.16	3.11	1.58	4.46	10.30
1990-91	2.52	2.10	0.93	4.88	10.43
2000-01	3.20	1.326	0.59	5.69	10.80
2006-07	4.07	0.906	0.50	5.18	10.58

Source: BBS, FPMU

For small country of 14.4 million ha, Bangladesh has large population in the world, with 1088 persons/km². Bangladesh population, currently increasing at 1.48% per annum will swell to 195.53 million by 2030. To feed these people, almost 39.8 million tonnes of rice will be required (Table 3). To feed this population, average yield of rice will have to increase from 2.58 t/ha to 3.8 t/ha (Table 3). The challenge facing the policy makers, administrators, and the rice scientists are formidable in as much as there is little scope to expand the rice area. It is assumed that rice area may further decrease with increase in population, land degradation and climate change.

Table 3. Projected population, population growth rate, land man ratio and demand and yield of rice, 1995-2030

Year	Population (M)	Population growth rate (%)	Land-man ratio	Demand for rice (Mt)	Present and required yield (t/ha)
1995	109.8	2.03	0.087	16.8	1.8
2000	132.4	1.79	0.072	23.9	2.4
2010	145.9	1.36	0.062	29.8	2.8
2020	170.91	1.16	0.053	35.5	3.4
2030	195.53			39.8	3.8

Source: BARC (1994) BBS (2008)

3.2 Rice Eco/culture Types and MV Adoption

Modern rice varieties (MV) cover varying proportion of cultivated rice areas, depending on the season and culture type. The highest MV area (96%) is in the boro season, producing the maximum yield 3.4 t/ha (Table 4), followed by 65% in rainfed, medium high land T. Aman and 50% in the direct seeded and transplanted Aus and 20-26% in the tidal wet land boro-aus saline area. The lowest MV area (14%) is in the T. Aman tidal wet land, weakly saline area (Table 4) growing mostly the traditional varieties. No MV rice variety is developed for the deepwater rice ecosystem and only one variety just released (BRRI dhan 47) for the saline ecosystem. Table 4 summarizes the present level of adoption of MVs in different seasons under different culture and ecotypes and number of MVs rice developed for these land and culture type.

Table 4. Seasons, Eco/culture type, Area, MV area and Yield of different ecotypes in Bangladesh, 2005-06

Seasons, area and time	Ecotype/ culture type	Area (Mha)	Yield (t/ha)	MV area (%)	MV rice (no.)	Remarks/ Problems
Boro, 4.065 Mha (Dec-May)	1. Irrigated rice (inland area)	3.70	3.4	96	23	Including hybrids and cold problems.
Aus (1.034 Mha), Mar-Aug.	2. Direct Seeded Aus (Upland rice)	0.23	1.28	-	6	Drought prone area.
(May-Aug)	3. T. Aus (Partial irrigated)	0.42	2.09	50	12	-
Boro-Aus (tidal wetland) 0.75 Mha	4. Tidal wetland (Boro-Aus, saline)	0.75 (0.35 Boro)	-	20-26*	1	BRRI dhan 47, salt tol. var., saline area
T.Aman, inland 4.92 Mha (June-Dec)	5. T. Aman (Rainfed, medium high land)	3.89	1.99 (2.35 for MV)	65	21	Drought, inland submerged prone area
T. Aman, (tidal wetland)	6. T. Aman (tidal wetland,	1.035	-	14*	5	2 var. proposed. coastal area,

Seasons, area and time	Ecotype/ culture type	Area (Mha)	Yield (t/ha)	MV area (%)	MV rice (no.)	Remarks/ Problems
(June- Dec.)	weakly saline)					weakly saline and submergence prone area
Broad cast Aman 0.506 Mha (Mar-Nov)	7. Deep water rice (medium low land)	0.505	1.17	-	-	Water depth 1-3 m

Source: BBS (2008) and **Table 5.** * target area to expand MV acreage

To meet the future demand for rice, the area under MVs has to be increased from the present 74% to 85%. To achieve this goal, varietal development for tidal, saline and drought prone area, improved production practices, quality inputs specially the seeds, fertilizers and high cropping intensity are needed. The socio economic and environmental issues must also be addressed. The varietal characteristics needed for different seasons and eco-cultural type varies for yield, plant height, growth duration, and reaction to biotic and a biotic stresses. Nasiruddin, (1994) determined the characteristics required for each ecotype.

4.0 Rice Research Progress

4.1 Varietal Development with Emphasis on Hybrid Rice and Biotechnology

During last five years (2004-08), BRRI released nine varieties BRRI dhan 42 to BRRI dhan 50 for three seasons with different characteristics which are described as follows:

Variety	Season	Maturity (days)	yield (t/ha)	Remarks
BRRI dhan 42	Direct seeded aus	100	3.5	Drought tolerant
BRRI dhan 43	Direct seeded aus	100	3.5	Drought tolerant
BRRI dhan 44	T. Aman	145	6.5	Tidal wetland
BRRI dhan 45	Boro	145	6.5	BR28 type
BRRI dhan 46	T. Aman	124	4.7	Nizersail type
BRRI dhan 47	Boro	150	6.0	Salt tolerant
BRRI dhan 48	T. Aus	115	4.5	Replacement of BR26

BRRI dhan 49	T. Aman	130	6.0	Replacement of BR-11
BRRI dhan 50	Boro	155	5.0	Basmati type/BR28
Proposed Variety				
BR 5778-156-1-3-HR 14	T.Aman (Salinity tolerant)			
BR 5999-82-3-2 HR 1	T.Aman (Salinity tolerant)			
BR 11-sub 1-R 1	T.Aman (Submergent tolerant)			
Swarna-sub 1	T.Aman (Submergent tolerant)			
BR 11-sub 1	T.Aman (Submergent tolerant)			

Out of these nine varieties only BRRI dhan 44 and BRRI dhan 47 can be cultivated in the coastal region. Other varieties will be the replacement of the existing varieties.

BRRI started research on hybrid rice for more than one decade and three hybrid rice varieties were released but the acceptance of these hybrid varieties not satisfactory. Similar is the case of biotechnology research for variety development. No significant contribution can be seen from this important area. Recently, two varieties for salinity tolerant and three varieties for submergent tolerant are proposed for release as varieties. Of the three submergent tolerant varieties, two popular varieties, BR 11 and Swarna were improved through biotechnology. These two varieties are expected to cover new areas in the coastal region.

Rice Research Progress in Bangladesh Institute of Nuclear Research

Released varieties				
Variety and year of release	Season	Maturity (days)	Yield (t/ha)	Remarks
Iratom-24	Boor	140-145	6.5	Up to 4 ⁰ C elevated temperature tolerant
	T. Aus	125-130	3.5	
Binashail	T. Aman	135-140	4.2	partially photo insensitive, for flood rehabilitation, needs less water and fertilizers
Binadhan-6	Boro	160-165	7.5	Up to 4 ⁰ C elevated temperature tolerant
Binadhan-7	T. Aman	110-115	5.5	Can escape drought and tolerant to BPH

Proposed varieties				
Line	Season	Maturity (days)	Yield (t/ha)	Remarks
PBRC(STL-20)	Boro	125-130	4.0-4.5	Can tolerate up to 10 dS/m salinity
PBSAL-655	Boro	130-135	3.8-4.2	Can tolerate up to 10 dS/m salinity
RC-43-28-5-3-3	T. Aman	120-125	3.2-3.7	Long slender grain with high aroma

4.2 Diseases and Insect-Pests Management

Diseases and insect pests cause about 10-15% loss in rice production. It was suspected that the brown spot disease of rice caused by *Helminthosporium oryzae* a fungal disease was one of the causes for the famous Bengal famine in 1942-43.

Diseases: There are many diseases of rice. Of these, 31 diseases are observed in different times, in different regions and in different varieties. Of the diseases, two are virus, 3 bacterial, 21 fungal and 5 are caused by nematodes. Ten of these are major diseases of the rice plant. These are bacterial blight (BB), blast (bl), sheath blight (ShB), rice tungro virus (RTV), ufra, leaf scald, bakanae, brown spot, stem rot and sheath rot. None of the rice varieties could be called resistant (R) against any of these diseases. Some are susceptible(S), some moderately susceptible (MS) and the rests are moderately resistant (MR).

Considerable yield losses could be minimized through proper cultural management, judicious and balanced use of fertilizers, and by appropriate use of chemicals.

Insect-pests: Due to intensive rice cropping and favourable environment, prevalence and attack of insect pests are increasing. As such, control and management of harmful insect pests are important. By controlling the insect pests in Boro, Aus and T.Aman, farmers can save about 13, 24 and 18 percent of crops respectively.

There are 175 harmful insect-pests so far recorded for rice. Fifteen major insect pests are yellow stem borer, rice hispa, brown plant hopper, white backed plant hopper, green leaf hopper, rice bug, swarming caterpillar, ear cutting caterpillar, rice case worm, gall midge, thrips, leaf roller, grass hopper, rice mealy bug and rice maggot.

For each of these insect pests, chemical and management practices to minimize the yield losses are identified and provided to the extension personnel and farmers.

4.3 Crop Adaptation to Climate Change and Coastal Agriculture

Unlike the middle and north-western region, the coastal region is relatively less affected by drought, cold and flood. Out of the total 2.8 Mha of the cropped land, rice area ranges from 79% in Barisal and Noakhali to 85% in Khulna. In spite of higher areas under rice, area under MV rice is 6%, 14% and 20% respectively in Aus, T. Aman and Boro seasons respectively (Table 5). Reasons of low adoption of MVs are both socio-economic and the environmental. The most important environmental factors responsible for low adoption of MVs are salinity and tidal flood. The socio-economic factors are owner-tenant interest, resource constraints for turn-around time between T.Aman and Boro season. Climate change will add another dimension and the coastal region will be the first target of the climate change. The impacts of climate change on rice production are briefly described below.

Table 5. Rice Area (ha) in four coastal districts of Bangladesh during 2005

Regions	Gross cropped area	Aus (local)	Aus (HYV)	Aman	Aman (HYV)	Boro	Region total and (%)
Khulna (3 districts)	413772	13362	8689	147263	77278	103718	350311 (85%)
Barisal (6 districts)	979862	164812	35165	441272	38696	95734	775079 (79%)
Noakhali (3 districts)	445295	83296	21087	139709	39596	66624	350312 (79%)
Chittagong (2 districts)	367720	31326	36223	49279	102661	90712	310201 (84%)
Seasons total and (%)	2206644	242796 (16%)	101164 (6%)	777523 (44%)	258231 (14%)	356188 (20%)	1785903 (81%)

Source: BBS (2008) Statistical Pocket Book

Table 6. Rice Area (ha) in three hill districts of Bangladesh during the year 2005

Districts	Gross cropped area	Aus (local)	Aus (HYV)	Aman (local)	Aman (HYV)	Boro	District total and (%)
Banderban	88113	15393	4941	3147	6747	4395	34623
Khagrachari	70380	5884	6434	6729	14660	12097	45805
Rangamati	65833	9687	1917	4928	9082	14936	40250
Season total and (%)	224326	30964 (26%)	13192 (11%)	14804 (12%)	30489 (35%)	31228 (26%)	120678 (54%)

Source: BBS (2008)

Table 7. Salt affected areas under different salinity categories in the coastal district of Bangladesh

District	Percentage of arable land under diff. salinity				Total salt affected area (000 ha)
	S ₁ (2-4 mmhos/cm)	S ₂ (4-8 mmhos/cm)	S ₃ (8-12 mmhos/cm)	S ₄ (12 mmhos/cm)	
Khulna	9.6	47.2	9.9	3.8	388(70)
Barisal	3.0	10.2	-	-	82(13)
Patuakhali	45.5	14.4	-	-	224(60)
Noakhali	3.6	10.9	1.2	-	77(16)
Chittagong	4.4	4.6	3.7	2.8	105(15)

Note: Figures within parenthesis indicate percent area

Source: Master Plan Organization

Table 8. Apparent nutrient balance sheet for three rice crops per year over eight years, BRRI, Bangladesh, 1984-91

	Yield: 10.50 (t/ha)						
	N	P	K	Ca	Mg	S	Zn
Nutrient added (kg/ha per year)	285	87	134	100	12	48	0.36
Nutrient removed (kg/ha per year)	179	29	179	46	39	19	0.47
Gross balance	+107	+58	-15	+54	-37	+29	-0.11
Net balance	-79	-12	-112	-26	-36	-9	-0.83

Source: Bhuiyan, (1992). Net balance is calculated based on use efficiency of different nutrients such as N-35%, P-20%, K-50%, Mg-20%. Zn-10% from chemical fertilizers

Global warming and other climate changes due to increasing concentration of green house gas (GHG) is expected a threat to agriculture. Climate change will have multiple effect such as rise of sea level (RSL), cause change of land types from one class to

another, change in the coastal zone, beach erosion, built up of soil salinity, rise of temperature, increase in concentration of CO₂ and moisture stress. Each of these factors will have impact on rice.

It was reported on December 11, 2009 in the Samakal news paper by Dr. Z. Karim that due to change of climate, already 0.17 Mha of land turned into salinity in the coastal area. It was also reported by IPCC that mean temperature rise in this century will be higher than the last century. By the end of century, mean temperature will rise from 1.8 °C to 4.0 °C and sea level rise will be from 0.18 m to 0.89 m. Rice yield loss study through a model run for 0 °C, 2 °C and 4 °C temperature rise at three levels of CO₂ (330, 580 and 660 ppm) were done for Aus, T. Aman and Boro season under two scenarios, CCCM and GFD over several locations. In general, increase of CO₂ levels increase in temperature to 40 °C reduced the yields of Aus and Aman in same cases compared to baseline yields. The change in yield of Aus and Aman varied between -14% to +25%. However, in case of boro yields, even at 40 °C temperature rise, and 13% and 20% yield increase were noted, at 580 ppm. In most cases, doubling of CO₂ level compensated the adverse effect of temperature rise (DOE, Global Climate Change-Bangladesh Episode, 1997). But for rise of sea level and salinity, rice scientists have to face the challenge of developing suitable varieties for submergence and salinity tolerant varieties through the use of biotechnology.

4.4 Drought Management

Annual rainfall in Bangladesh ranges from 1400 mm in the dry Rajshahi (North West) region to over 5000 mm in the wet Sylhet (North east) region. About 90% of the rainfalls occur generally during June to September, but distribution of during these four months varies greatly. Another complexity is the occurrence of different soil and land types in the country. There are variety of soils varying with respect to moisture holding capacity, infiltration and other moisture related properties. The soils are broadly grouped into flood plain, terrace and hill soils which are distributed over five major land types. Crop suitability is largely dependent on the land types, as it relates to the annual normal flooding. High land (F0) and Medium high lands (F1) are most suitable for modern transplant aman rice cultivation. But due to uncertain rains and its uneven distribution, drought of different magnitudes occurs during the

T. Aman season. Drought in T. Aman season has a great impact on the rice production of the country for the following reasons.

Table 9. Intensity of drought and yield reduction of broad cast Aus and T. Aman in Bangladesh

Drought Classes	Area (Mha)	Yield reduction (%)
	<u>Aus</u> T. Aman	<u>Aus</u> T. Aman
I. Very severe	<u>0.36</u>	<u>>40</u>
	0.57	>45
II. Severe	<u>0.86</u>	<u>30-40</u>
	1.74	35-45
III. Moderate	<u>3.28</u>	<u>20-30</u>
	2.17	20-35
IV. Slight	<u>4.3</u>	<u><10</u>
	2.95	<20

Source: Karim, *et al.* (1990), BARC

- Early drought delays transplanting of aman rice and shifts the harvest affecting Rabi crops, which results in fallow area after T. Aman.
- Early drought reduction, tillering and vegetative growth which reduces the yield.
- Maximum susceptible factor for T. Aman is during heading, panicle initiation and dough stage of ripening.
- Thus, drought in the later growth period of T. Aman may cause large yield reduction. The losses may be greater than 50% in some regions in some years.

During Rabi season, the evapotranspiration exceeds mean monthly rainfall on November to March. Thus soil moisture supply during this period is not compatible to needs.

In the light textured soil with high infiltration rate, rabi crops are more vulnerable to moisture stress. Realizing the importance and impact of drought, estimated loss of yield of different crops, BARC prepared drought classification maps. Drought tolerant T. Aman variety with about 120 days growth duration need to be developed and BRRI initiated research on water management technology to deal with drought, salinity and water saving through alternate drying and wetting (ADW).

4.5 Yield Gap and Yield Loss in Rice Production

Bangladesh experienced intensive rice production in the recent years. The increased production has been weakened due to several factors. The increased rice production through the adoption of existing management practices has nearly been exhausted. There is a growing realization that the potential of the existing technologies has not been achieved leading to a substantial yield gap between the potential and the average farm level yields.

Rice yield, in the recent years in all rice production environments, has come to a halt despite adoption of improved package of practices. It is mainly due to yield losses for both biotic and abiotic stresses. It is therefore, necessary to take steps to reduce such large gap between the potential and normal yield at farm level. It is evident that abiotic stresses are much more severe than the biotic ones (Table 11).

Considering the maximum and minimum farm level yield, the gap is estimated at 1.44 t/ha or about 40% of the maximum yield (Table 10). There exists a yield difference of 2.7 t/ha between the maximum yield achieved in irrigated and rainfed situations, respectively. This gap could be reduced if appropriate MVs could be developed for rainfed situations. Among the biotic stresses, the important ones are stemborer, rice hispa, rice bug, brown plant hoppers, bacterial blight, blast, sheath blight, tungro virus and ufra. In abiotic stresses both drought and submergence at different growth stages of rice plant are causing substantial yield losses under all cultural types. Rice yield losses due to weeds are also at substantial higher level (Table 11). The priority research area are, therefore, set in order of importance, submergence at anthesis, drought at anthesis, submergence at vegetation, stemborer, weeds, sulfur deficiency, zinc deficiency, rice hispa, bacterial blight, blast and organic matter deficiency (Table 11).

Table 10. Farmers' experiences with rice yields by culture types and by season (kg/ha)

Culture types/season	Normal yield	Maximum yield	Minimum yield	The gap between	
				Maximum and Normal yield	Maximum and Minimum yield
Rainfed	1968	2468	1426	500	1042
Direct seeded aus	1664	2161	1204	497	957
Direct seeded aman	1836	2323	1409	487	914
Transplanted aman	2252	2758	1609	506	1149
Irrigated	4095	5193	3158	1097	2032
Transplanted aus	3191	4116	2388	925	1728
Transplanted aman	3806	4797	2899	993	1899
Transplanted boro	4585	5832	3591	1247	2241
Average	2815	5832	3591	740	1439

Source: Farmers Household Survey, Alam *et.al.*, 1998

Table 11. Yield gap and Yield loss from various stresses, estimates from farmers' perceptions

Stresses	Normal yield loss		Percent share of stresses to total loss	Estimates of Production losses in Bangladesh	
	kg/ha	As% of farm level yield		Mt	Million US\$
Insect pests	151	5.4	19.5	1.52	304
Diseases	76	2.7	9.8	0.76	152
Weeds	64	2.3	8.2	0.64	128
Drought	138	4.9	17.7	1.38	276
Submergence	205	7.3	26.4	2.06	412
Heat and cold	7	0.2	0.9	0.07	14
Soil related stress	136	4.8	17.5	1.36	2.72
Total	777	27.5	100.0	7.79	1558

Source: Alam *et al.*, 1998

4.6 Hill Rice and Agriculture

Bangladesh has 14.4 million hectare (Mha) of land, 8.2 Mha (56.57%) is under cultivation. Though, the net cropped area did not change significantly, but the gross cropped area increased from 13.16 Mha in 1980-81 to 14.3 Mha in 2000-01 and cropping intensity (CI) increased from 154% to about 180% during the same period. Rice is the dominant crop that covers 76.32% of the total cropped area. Bangladesh Agricultural Research Institute (BARI) has three research stations in each of the three hill districts but Bangladesh Rice Research Institute (BRRI) does not have as yet any research station in the hill regions.

There was no specific research done on rice for the hill region and not much information available on problems of rice production. A survey report published by BARD, Comilla on Hill Agriculture, a socio-economic analysis published in 2006. Most of the information provided in this report is based on that report.

Area and location: Three hill districts, Bandarban, Khagrachari and Rangamati has an area of 13,295 km² which is about one tenth of the country. It is situated between 21.5⁰ and 23.25⁰ north latitude and between 91.45⁰ and 92.5⁰ east longitude. The highest elevation is 3000 ft and the annual rainfall ranges 2000-3500 mm.

Population: There are twelve ethnic groups in the hilly region. The population in the region increased from 1,25,000 in 1901 to 9,74,000 in 1991 with population growth rate 2.4%. Pahari population was 51.4% in 1991 against 93% in 1901.

According to the traditional social system, the region is divided into three administrative circles, as Chakma, Mong and Bomang. The circle chief, collects land taxes, allocation of lands for cultivation and control minor offences.

Land and Soil types: The land type consists of 77% high land, 20% undulating and bumpy land and 3% plain land. The soil is sandy loam to clay loam, usually strong brown colour, PH ranges from 4.5 to 6.0/.

Crops, Cropping Pattern and Cropping Intensity: The major crops are rice, maize, cassava, banana, turmeric, ginger, cotton, various fruits, vegetables and timber trees. The cropping patterns vary according to the slope of the land. *Under very gentle slope* (15%) the pattern is Boro-Fallow-T.Aman, winter Vegetable-T.Aus-T.Aman, winter Vegetable-Fallow-T.Aman, Fallow-(Aus+Maize)-T.Aman, *under the medium slope* (15-30%), Fallow-Jhum crops, Citrus/Guava/ Banana/(Jackfruit +Pineapple), *under steep slope* (30-35%), the CP is Fallow-Jhum crop and Fruits + Pineapple/Pigeon pea/Sesame *under high steep slope* (50-70%) the dominant CP , Jackfruit-Twrarind/Hardwood and lastly *very high steep slope* (70%) the dominant CP is hard wood and forest species.

The cropping intensity (CI) is 186% in hill region against 180% in plain land.

Land tenures system: From the survey report, the land ownership was 61% own land, 34% lease, 2.33% mortgage and only 3% share croppers. The landholdings in the survey area are 32% landless, 36% small, 27% medium and 3.34 large farmers.

Rice area, Variety and Yield: As per BBS (2008), the total cropped area in the three hill districts are 0.224 Mha and the area under rice is 54%. The district wise area in three seasons of Aus, T. Aman and Boro and the area under the local and HYV's are shown in Table 6. Area under HYV in all seasons is low compared to the national average of HYV area of 74% (Table 1).

The yield of rice in the Aus, Boro and T. Aman seasons are 3.38, 3.95 and 4.20 t/ha, respectively. The lower yield in Boro season compared to T.Aman may be due to problem of irrigation in the season.

5.0 National and International Co-operation in Rice Research

International cooperation is important for human resource development, technology development, exchange of germplasms and access to scientific information in rice research and production. IRRI played major role in the development of BRRI's human resources, exchange of germplasms and information. In future, BRRI should develop cooperation with India, China, Korea, Japan and the USA for development of biotechnology, hybrid technology, seed technology and genetic resource conservation. Bangladesh needs qualified human resources.

Crop biotechnology provides opportunities to develop variety with genetic traits that are difficult to achieve using conventional breeding methods. The farmers are facing serious challenges due to global climate change, insurgence of new and virulent races and biotypes of pests and diseases. Biotechnology has great potential to solve all these problems.

- i) **Gene discovery:** Identification and isolation of genes inducing tolerance to biotic (insects: brown plant hopper, stem borer, diseases, bacterial blight, tungro etc.), abiotic stresses (such as drought, salinity, submergence and cold) and genes controlling micronutrient condensation are important.
- ii) **Application of useful DNA markers:** Identification and mapping of major QTLs for high grain yield, tolerance to salinity, drought, submergence as well as major plant diseases and insects. Transfer of useful QTLs into target background through Marker Assisted Selection (MAS).
- iii) **Transgenic technology:** Cloning and characterization of agronomically important traits. Introduction and development of useful transformation vector. Finally development and evaluation of transgenic rice having tolerance to biotic and abiotic stresses as well as improved nutritional quality.
- iv) **Molecular technology:** Molecular characterization of rice germplasms to protect biopiracy and identification of potential donors having useful agronomically important genes are important. Studies on gene expression, regulation and their use in crop improvement.

6.0 Field Problems and their Ranking

The field problems and their ranking done in the greater regions of Barisal, Bogra, Chittagong and Mymensingh are shown in Annexure VI. A summary of the information provided in Annexure VI, are given in Table 12. Some field problems/issues are specific to one/two regions but two field problems/issues are common or reported from all the four regions. These are requirements of short duration rice varieties for all seasons and problems with irrigation water (Table 12).

Table 12. Summary of field problems and their ranking in different regions.

Sl. No.	Problems/issues	Region and Ranking			
		Barisal	Bogra	Chittagong	Mymensingh
1.	Short duration rice var. for Boro, Aus and T.Aman seasons	Medium	High	High	High
2.	Submergence tol. Var. (Inland)	-	High	-	High
3.	Tidal submergence tol. varieties	High	-	-	-
4.	Salt tol. varieties	High		High	
5.	Development of varieties for jhum cultivation		-	High	-
6.	Hybrid rice	High	-	Medium	-
7.	Development of photo period sensitive T. Aman varieties	-		-	High
8.	Rice mechanization	-	-	-	High
9.	Drought/cold tol. varieties	-	-	-	High
10.	Bacterial blight resist varieties	High for Hybrid rice	-	-	-
11.	Sheath blight resist varieties	-	Medium	-	-
12.	Brown plant hopper resist varieties	-	Medium	-	-
13.	Fe and As problem	-	High	-	-
14.	Land tenures system	High	-	-	-
15.	Poor management of sluice gates	High	-	-	-
16.	Poor quality seeds	-	-	-	Medium
17.	Problem of irrigation water	High	High	High	High

Source: Annexure VI

7.0 Comments/Suggestions of Workshop Participants

A workshop on the draft report of priority rice research vision document 2030 and beyond was held at BARC, on 8th March 2010. The group leader on rice appreciated the comments / suggestions of the workshops participants. These are shown in Annexure-VI.

In fact field problems, technology development and adoption problems, administrative and policy support problems etc. are more or less known to the concerned organizations. The group leader prepared the draft report through holding three group workshops with the relevant research organizations on rice. As per request of the group leader, the relevant research organizations submitted their 5 year research plan (2010-2015). From the 5 year plan, through discussion, priority research agenda were identified as shown in Annex-1.

There were reports on (i) Soil and fertility management (ii) Agricultural mechanization and water management (iii) and Agricultural economics, marketing and yield gaps etc. Some of the comments/suggestions of these reports are related. However, some of the comments/ suggestions relevant to rice group are included in the final report. Specially the comments of BARC, BINA and on yield gaps are included in the final report. Some of the suggestions are included in the recommendations for future actions. The research agenda is a 5 year perspective plan for a research vision document 2030 and beyond.

8.0 Conclusion and Recommendations

1. The dedicated, qualified and experienced human resources are the backbone of scientific research. The creative human resources are to be nurtured in the NARS system for the ultimate success of any scientific adventure. Due to lack of carrier planning, rewards and advancement through promotions; the morals and the professional standards of scientists are at jeopardized conditions. Due to these situations, many NARS scientists migrated abroad. The promotions opportunities in the NARS system are far below the neighboring countries and the public universities of Bangladesh. The sooner this deep seated malady is removed, will be the better for the country. Otherwise, the

country will face serious vacuum of dedicated, qualified and experienced scientists to face the challenge of vision 2030 and beyond.

2. The research planning, management and implementation may be carried out on a 5 year perspective master plan basis, through seasonal and annual activities. With proper monitoring, guidance and evaluation and through necessary changes/ modification during implementation period, the ultimate goal/objectives of the desired research vision 2030 and beyond may be materialized.
3. There is a general agreement/consensus that yield gap in rice production is wide. The reasons/factors responsible for this yield gap have to be correctly diagnosed and minimized through experimental studies in different seasons.
4. We may have to seriously consider minimizing post-harvest losses due to Engle-bar rice milling process. Such type of milling perhaps does not exist anywhere in the rice producing countries except Bangladesh. We have to introduce rubber-roll for rice milling by which we may have rice husk and bran industries for fuel and poultry, respectively.
5. The biotechnology research within and between the crop sector institutes are mush-rooming. In that context, hybrid technology research is almost absent. We can, with less efforts and costs, bring more benefits through hybrid technology. We should, as a LDC, put equal emphasis on conventional breeding, hybrid technology and biotechnology.
6. The genetic resources of any crop are the basic raw materials for varietal development. So, the collection of remaining (if any) of land races of rice with passport data, conservation, characterization, should be done with priority to be utilized in the breeding programmes and for patenting the land race of Bangladesh.

7. We should have strong regulatory system for the exchange of genetic resources of any crop within and between the countries. We have to develop also a strong and viable regulatory system to handle GM crops.
8. The intra and inter institutional co-ordination and cooperation for particular research to avoid/reduce duplication/overlapping should be strengthened. Though, some duplication may be desirable to create competition but this should be properly regulated, guided and evaluated.
9. The hybrid rice research is rather weak and not satisfactory. The hybrid rice research should be strengthened under the revenue budget of the plant breeding division of BRRI and not as a separate autonomous entity, as it is done at present.
10. Short duration rice varieties for all seasons, especially T. Aman season, about 120 days, with drought tolerance and resistance to bacterial blight, sheath blight, sheath rot, blast etc., should be given priority.
11. Drought stress is going to be a concern for T. Aman/rabi crops due to climate change etc. It is one of the major causes of yield loss/gaps. So, water management through supplemental irrigation, water saving technology, efficient water management from surface water sources by re-excavations of rivers, canals, beels and other water bodies should be undertaken on priority basis.
12. The seed is one of basic and important inputs for higher productivity. The quality seeds of popular varieties with reasonable prices at proper time should be made available to the farmers by the public/private/NGO sectors. The certified seed (CS) of public sector should be certified by SCA and the truthful level seed (TLS) of the private sector should also be properly monitored by SCA as per seed policy and seed laws. In that context, present seed laws may be modified for the interest of the farmers (e.g., Indian case) of the country.

13. It is important to pay greater attention to transfer and adoption of technology, for promoting higher productivity, profitability and sustainability. It is also important to identify and address farmers' adoption problems (suitability of technology, input and technology transfer systems, infra structures, institutional support, policy directives and interventions).
14. It is important to re-orient extension and technology transfer systems and to train the extension/development staff to effectively handle the transfer of knowledge intensive technologies (KIT). A new horizon may be established to further strengthen research-extension-farmers linkages to deliver information, knowledge, technology packages, based on participatory and freely communicative approaches. This calls for judicious collaboration among the NARS, DAE, BADC, SCA, Private Sector, NGOs and the International Organizations.
15. To further raise the yield ceiling, the hybrid rice, transgenic rice (GM) for management of biotic and a biotic stresses, simulation modeling and system approach should be developed. New mechanisms for assessment and transfer of such technology will also be urgently needed.
16. It is important to develop suitable indicators of intensifications and sustainability to monitor the performance of intensive rice cropping/farming systems.
17. The govt. policies on intensive cropping/farming systems should be defined, ensure system sustainability, food security and reduce rice farming related pollution of the environment. We may think to discourage parboiling of rice, at least in 50% case.

9.0 Research Priorities

9.1 Research Agenda/Thematic Areas

Problem/ Constraints/ Areas	Research Title/ Key Words	% of beneficiary	Probability of success	Priority Ranking	Research Tenure		
					Long	Med	Short
Varietal improvement	1. Development of short duration var. for all seasons with emphasis for T. Aman (BRRI-BINA)	Area, 2.0 Mha (20%)	80%	1	✓		
Varietal improvement	2. Strengthening hybrid rice research in Boro and T. Aman seasons (BRRI-BSMRAU)	Target, Boro 30% area and T.Aman 20% area by next 10 years.	Boro 100% T.Aman 75%	1	✓		
Coastal agriculture and crop adaptation to climate change	3. Development of salt tolerant var. for Boro and Aus seasons (BRRI-BINA)	Area, Boro 0.356 Mha and Aus 0.3939 Mha (80%)	80%	1	✓		
Coastal agriculture and crop adaptation to climate change	4. Development of submergent tolerant var in T.Aman season for tidal wetland and inland area (BRRI-BINA)	Area, tidal wet land 1.0 Mha and inland 30% of T.Aman (1.2) Mha	80%	1	✓		
Pest management and biotechnology	5. Identification of races and biotypes of major diseases and insect pest of rice and mapping of R-genes of BB, Bl and BPH using molecular markers (BRRI).	Basic research for var. improvement (100%)	80%	1	✓		

Problem/ Constraints/ Areas	Research Title/ Key Words	% of beneficiary	Probability of success	Priority Ranking	Research Tenure		
					Long	Med	Short
iotecnology and plant pathology	6. Introgression of salt tolerance and gene pyramiding for BB and BL in popular rice varieties (BBRI)	100% Plant Breeder	80%	1	✓		
	7. Water Management to deal with drought, salinity and water saving.	Drought area 1.39 Mha (BBRI) 100% of adopters	80%	1	✓		
Rice post harvest technology	8. Up scaling of rice milling and Processing (BBRI)	100% of rice miller and processors	80%	1	✓		
Rice economics marketing and policy	9. Impact of MV rice, marketing and price policy (BBRI)	Basic study	80%	1	✓		
Rice farming system	10. Identification of rice based cropping in 3 hill districts, its environmental and socio-economic analysis (BBRI)	50% of farmers	80%	1	✓		
Rice farming system	11. Intensification of rice based cropping in major areas (BBRI)	50% of farmers	70%	2	✓		
Technology transfer	12. Role of stake holders analysis in rice technology dissemination (BBRI-DAE)	Basic study	80%	2	✓		
	13. Role of quality rice seed for increasing rice productivity (BBRI-BADC)	Basic study	70%	2		✓	

10.0 Five Years Research Plan (2010-2015)

10.1 Bangladesh Rice Research Institute (BRRI)

Varietal Development

Projects	Priority
1. Development of rice varieties tolerant to tidal submergence under both saline and non saline condition	1
2. Development of short duration, high and stable yielding rice varieties for the Boro, Aus T. Aman seasons to fit into the diverse cropping patterns	1
3. Development of premium quality rice	2
4. Development of varieties tolerant to flash flood submergence and medium stagnant condition	1
5. Development of varieties for salt tolerance in Boro, Aus and T. Aman ecosystem.	1
6. Development of varieties for drought tolerance in upland Aus and T. Aman ecosystem	1
7. Development of varieties for high iron rice and zinc	3
8. Variety maintenance and production of breeder's seeds	2
9. Use of biotechnology for rice varietal development	2
10. Plant genetic resources conservation and management	1
11. Hybrid rice and seed production technology	1

1= Top priority, 2=Moderate priority, 3=Low priority

Characteristics of Varieties for different ecocultural types

1. Boro (Irrigated)

Development of high yielding (7-9 t/ha), varieties having-

- Short (120 days) and long growth durations (135-160 days);
- plant height (85-110 cm);
- resistance to biotic factors (BB, BL, ShB disease and BPH, WBPH, stemborer insect pests);
- tolerance to cold both at vegetative and reproductive phases;
- tolerance to salinity at vegetative (10-14 dS/m) and reproductive phase (6-10 d S/m);
- resistance to pre-harvest sprouting;
- acceptable and fine grain quality with or without aroma.

2. Upland Aus (Rain fed)

Development of direct seeded short duration (85-90 days) high yielding (2-3 t/ha) varieties having-

- faster seedling emergence suppressing weeds;
- plant height between 90 and 110 cm;

- salinity and drought tolerance and lodging resistance;
- resistance to pre-harvest sprouting;
- resistance to BB, blast, RTV diseases and GLH. BPH. insect pests;
- acceptable grain quality.

3. Transplant Aus (Partially irrigated)

Development of short duration (100-115 days) high yielding (4.5 t/ha) varieties having-

- plant height ranging between 90 and 100 cm;
- resistance to lodging and pre-harvest sprouting;
- resistance to BB, blast, RTV diseases and GLH insect pests;
- resistance to high temperature/heat tolerance;
- acceptable grain quality.

4. Tidal wetland (Boro-Aus saline)

The varietal characteristics in this eco-type are similar to Boro and Aus with tolerance to salinity.

5. Transplant Aman (Rainfed, medium highland)

Development of high yielding (5-7 t/ha) varieties having-

- taller seedling (30-60 cm) and plant height (120-140 cm); for tidal wetlands areas;
- growth duration ranging between 115 and 140 days;
- various levels of photoperiod sensitivity;
- tidal submergence tolerance, flash flood submergence and salinity tolerance;
- resistance to BB, blast, RTV, ShB, LR and BPH, Gallmidge, stemborer, WBPH insect pests; and
- fine grain quality with or without aroma.

6. T. Aman (Tidal wetland)

The varietal characteristics are similar to ecotype 5 with tolerance to tidal submergence and weak salinity.

7. Deepwater rice (Rainfed)

Development of varieties yielding 2.0-3.0 t/ha having-

- internodes elongation ability with submergence tolerance;
- plant height ranging 150-200 cm and above;
- kneeling ability and nodal tillering;
- moderate level of photoperiod sensitivity;
- high density bold grained panicles;
- resistance to pre-harvest sprouting, ufra and root knot.

8. Hybrid rice

1. Development of parental materials
2. Evaluation of parental lines & Hybrids.
3. Seed production

Biotechnology

Project 1. Gene Pyramiding

Introduction & Importance: Gene pyramiding is an exercise of introducing number of genes conditioning a particular trait into cultivars simultaneously. Thus, genes pyramiding ensure a variety uniform phenotype but carrying different genes against a target trait. Accordingly, a gene pyramid is the combinations of genes offering resistance to different biotic and abiotic factors. Pyramiding of several resistance genes in a single varietal background can achieve durable resistance. This goal can be most easily achieved using DNA markers. Subsequently, the linked markers can be utilized to select for the rare recombinants that combine the favorable alleles in tandem.

Gene pyramiding through conventional approach (involving phenotype based selection) is time consuming and laborious. The recent developments in plant biotechnology including molecular mapping and marker-assisted selection offer options for pyramiding of resistance genes in the genetic background of popular cultivars. PCR based marker assisted selection (MAS) helps in selection of segregating/backcross progenies possessing resistance gene(s) and shortening of the breeding cycle.

Methodology: First crossing the recurrent parents with the donors containing desire genes to generate F_1 and then screen of hybrids

having desire gene through marker aided selection. After selection, start creation of back cross generations up to BC₃ F₁ generation. In each generation, selection of plant containing the resistance genes and possessing more alleles of the recurrent parent will be done through marker assisted selection. Thus NILs will be developed as stated above. Finally evaluation of the pyramided lines for their levels of resistance and yield trial will be conducted.

Project 2. Gene Introgression

Yield enhancement of modern rice variety by incorporating trait-improving OTL from a wild rice species.

Introduction & Importance: Bangladesh is the fourth largest rice producer in the world and situated within the regions of origin of cultivated rice. Very few of local rice cultivars are grown. Moreover, some wild rice and related grass species are also endemic in the country. Many wild relatives of rice (*Oryza rufipogon*) share the same AA genome and are compatible sexually with cultivated rice. The wild species are valued as a unique source of genetic variation, they have been rarely used for the genetic improvement of quantitative traits. Because, the overall phenotype of most of the wild species is agronomically undesirable. However, recent studies by several groups have shown that despite its inferior agronomic performance, a wild rice, an accession of *Oryza rufipogon*, is likely to contain genetic factors that can increase the yield of modern variety. It was reported that *Oryza rufipogon* allele at tow OTL on chromosomes 1 and 2 were associated with 18 and 17% increase in grain yield per plant, respectively, without delaying maturity or increasing plant height. This discovery suggested that the innovative use of molecular maps and markers can alter the way to utilize wild and exotic germplasm for rice crop improvement program.

Materials and Method

Population development

The recurrent parent will be a modern rice variety (use as a female) and donor will be wild rice. First, F₁s will be developed. The F₁ plants will be grown in the net house and the three most vigorous F₁ hybrid plants will be backcrossed to the female, from which BC₁F₁ plants will be selected based on phenotype to eliminate non-desirable characteristics, including very late or non-flowering type,

excessively tall plants, and sterile plants. Then second round of back crossing will be carried out with modern rice and seeds of BC₂F₁ will be collected from which some BC₁F₁ seeds will be grown in the fields and subsequently best plants will be selected based on phenotype and harvested individually to generate BC₂F₂ seeds.

Field trials

Trait evaluation

Phenotypic evaluation will be done on BC₂F₂ population grown in various environments in BCBD with three replications. Proper management will be given up to maturity. Ten plants will be selected at random from each of the BC₂F₂ families in each experiment and evaluated for eight agronomic traits, including days to heading, plant height, panicle length, number of panicle per plant, per cent sterility, grain per plant, 1000 grain weight and yield per plant. Correlation among the traits will be evaluated using the trait average from all the experiments.

Marker & QTL analysis: SSR markers will be used for marker analysis to identify the QTL for desired high yielding region in rice chromosome(s).

Genetic Resources and Seed Component

Project 1. Variety Maintenance and Production of Breeder Seed, Priority 1

Table 1. Projected demand for Breeder Seed of rice during 2010-15

Year	Amount of Breeder Seed (t)	Multiplication rate (mr)
2010-11	100	80-100
2011-12	120	80-100
2012-13	150	80-100
2013-14	160	80-100
2014-15	180	80-100

The Role of Stakeholders Analysis in Rice Technology Dissemination (BRRI-DAE)

Introduction

To disseminate modern rice production technologies Bangladesh Rice Research Institute (BRRI) as well as the Department of Agricultural Extension (DAE) might have mechanism that works well. This study is a tentative approach to seek new techniques, to review as usual concepts and to formulate updated as well as dynamic strategies. All the stakeholders, i.e. the farmers, policy makers, scientists and extension providers along with the other partners, of rice research and extension services are at the focal point of the approach, as they are the real actors behind all the involvements as sparks. sponsor, shaper, sounding board and specialists. This study aims at revolving around them, as they are the user and catalyst of rice knowledge and technologies that may have the potentials to change the existing socio-economic scenario of the country.

Objectives

The objectives of the study are to:

- Discover out-of- the-box thinking for and against baseline concepts
- Prepare appropriate messages according to the stakeholders' needs
- Juxtapose the existing tools with the fresh ones
- Use field level findings with already validated knowledge
- Put forward alternative ideas and mechanism for rapid dissemination

Activities

Activities of the study should include:

- Surveying the farmers, service takers, policy makers, GO and NGO officials, scientists, extension providers about use and adoption levels of BRRI technologies including HYVs and more
- Organize workshop, seminars and conduct focus group discussions targeting apt communication strategies

- Develop models and test them in the actual field level operations
- Analyze data primary as well as secondary ones
- Measure, record, represent and analyze all the available data
- Formulate recommendations to implement new visions

Outcomes

The study can:

- Find out more effective ways and means of rice technology dissemination
- Build bridges of understanding between partners and stakeholders
- Map out dynamic communication techniques
- Generate primary data
- Accumulate and synthesize secondary data to further study
- Contribute to ensure food security minimizing yield gaps.

10.2 Bangladesh Institute of Nuclear Agriculture (BINA)

Project A. Mutation Breeding

Period	Research programme on mutation breeding
2010-2015	• Development of short durated high yielding varieties (7 t/ha) • Development of high yielding varieties of broadcast aman rice for the areas where transplanting of aman rice is not possible due to flood level about 1 m. • Development of high yielding export type varieties of fine grain aromatic rice for both aman (5 t/ha) and boro seasons (7 t/ha) • Development of varieties with high nutritional content particularly higher iron containing rice • Development of low water demanding HYVs and high water use efficient varieties of rice.
Project B. Biotechnology	
2011-2015	• Development of salt tolerant, submergence, temperature (both high and low) tolerant aromatic, higher nutritional value (Fe, Zn, Vitamin A, etc.) and early rice varieties using marker assisted selection

Period	Research programme on mutation breeding
	(MAS) • Development of green super rice varieties through MAS and gene pyramiding • Multiple stress tolerant/resistant rice varieties MAS, gene pyramiding and genetic engineering • DNA fingerprinting, molecular duration and gene discovery (special genes/target genes) for rice land races and HYVs.
Project C. Seed production, dissemination system strengthening and human resource development.	
Period	Quality seed production and technology transfer
2010-2015	• Increase of commanding area up to 5% with BINA rice varieties • Training of rice scientists for familiarization with recent research tools.

Output of Research:

Under mutation breeding 5-6 nos. of varieties and under biotechnology 7-9 nos. of varieties are expected to be developed within this period.

10.3 Bangabandhu Shiek Mujibar Rahman Agricultural University: Department of Genetics and Plant Breeding

1. **Achievements in hybrid rice research during the last five years (2005-10)**
 - a. Tested 300 local boro rice varieties against CMS sources for identification of B and R lines.
 - b. Eight 8 A and 4 R lines developed from local boro rice varieties through backcrossing between identified B and male sterile lines.
 - c. Tested 100 local aromatic rice varieties against CMS sources for identification of B and R lines.
 - d. Seven A and 3 R lines developed from local aromatic rice varieties through backcrossing between identified B and male sterile lines.

2. Hybrid rice research priorities for next five years (2011-2015) towards vision 2030 and beyond

Project-1: Development of hybrid rice and seed production technology for boro season

Objectives

To develop suitable A, B and R lines for different hybrid combinations with the following characteristics:

1. Plant height 85-120 cm
2. Growth duration 130-150 days
3. Resistance to BB, B1 and other diseases
4. Resistance to BPH and WBPH
5. Tolerance to cold at vegetative and reproductive phases
6. Medium slender and medium bold grains
7. Amylose content more than 25% with low glycemic index
8. Yield 7-8 t/ha/.

Project 11: Development of hybrid rice and seed production technology for transplanted aman season

Objectives

To develop suitable A, B and R lines for different hybrid combinations with the following characteristics:

1. Plant height 110-140 cm
2. Growth duration 120-140 days
3. Resistance to BB, B1, RTV diseases
4. Resistance to BPH, GLH, and WBPH insect pests
5. Photoperiod insensitive to sensitive
6. Submergence tolerance
7. Medium slender and medium bold grains
8. Amylose content more than 25% with low glycemic index
9. Yield-6-7 t/ha.

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Terms of Reference (TOR) of the Group Leader

1) Consultation and review of the documents related to agriculture and rural development. These are, but not limited to the following. To accomplish the task the team may need to visit the concerned institutes.

- Planning Commission Reports on five year plan, annual budgetary documents etc.
- National Agriculture Policy
- Poverty Reduction Strategy of the GoB.
- World Bank document on revitalizing agriculture and related others
- Agricultural sector review/Actionable policy briefs of the FAO
- Reports of the DFID, DANIDA and others on the performance of the agriculture sector in Bangladesh
- National Food Policy
- National Land Use Policy
- National Livestock Policy
- National Fisheries Policy
- National Forestry Policy
- Vision document- 2020 of BARC and Strategic plan of 1996
- Land, Soil and Management Of Natural Resources
- Reports On Food Security, Quality And Safety
- Reports on MDG
- Master Plan & Annual Reports of ARIs
- Websites on various agencies

(Source: BARC Library, P&E Division, BARC, Concerned Institutes, Websites of the concerned Ministry/Organization)

2) Through collection and collation of the information as stated in Sl-1, work out the countries situation/issues by the sub-sector/area (12 nos.) of agriculture. These are:

1. Rice
2. Cereals other than Rice, Sugarcane and Jute
3. Horticultural crops (Potato, Fruits, Vegetables, Spices including Flowers
4. Pulses and Oilseeds

5. Soil and fertility management
6. Forestry
7. Livestock
8. Fisheries
9. Agricultural mechanization and water management
10. ICT in agriculture
11. Agricultural economics, marketing and supply chain development
12. Technology development, agro-processing post-harvest technology, food quality and human nutrition

3) Sub-sectoral studies are expected to be in-depth and detailed in nature. This to cover all component's current trend in production, demand-supply and gap, opportunities, problems and constraints, required technological interventions and their analysis in the country's context. By the process determine the priority need of the concerned sector/area by the year 2030 and beyond.

4) Population dynamics, reduction in land resource base and degradation, issues pertaining to climate change & sea level rise (SLR), economics of commodity and non-commodity related activities, income growth rate etc. all these to be taken into account in formulating the research priority.

5) Undertake other related tasks as may be deemed necessary or evolved while performing this assignment.

6) Draft report of the teams to be presented in the workshops to be organized by the Planning & Evaluation Division of BARC at a suitable dates.

7) Draft final report incorporating the comments/opinion obtained from the workshop, different agencies/individuals to be submitted within 2(Two) months from the date of assignment to the MD (P&E), Bangladesh Agricultural Research Council.

Group Work Guidelines

- Step 1: After formal briefing, disperse by *group* of broad research area/sub-sector. Of course, this does not prevent an interested individual of other discipline to join/make change in joining a particular group of choice. Find the research area/sub-sector in the Annexure-I. In total there will be 12 groups.
- Step 2: The Group Leaders shall present his draft report prepared earlier in the group.
- Step 3: Group Leaders to initiate discussion and invite comments/opinion and ideas on the presentations and subject matter. The group together may first prepare the fatty '*wish list*' of the research agenda/themes, and then, through discussion and agreement identify those; which are most urgent, important and result-oriented and thus narrow down to the '*priority list*' of research agenda/thematic areas. Rapporteur/Member-Secretary to list down all the research agenda/thematic areas. Ideally this should not be more than 5.
- Step 4: During group work, the *Group Leader* and the *Rapporteur/Member-Secretary* to note deliberations. Group Leader to compile and incorporate those, if agreed to be required in the draft report
- Step 5: Under each priority research agenda/thematic area, list down most pressing *priority research topic(s)*. Exact title not really necessary at this stage but would be useful. May be only the key words in order to assist framing the title by the drafting committee.
- Step 6: Decide and fill the column of *Priority Ranking* agreed by majority (See Foot note of Annexure-I).
- Step 7: Decide and fill the columns of *Research Tenure* agreed by the group (See Foot note of Annexure-I).
- Step 8: Prepare group power point presentation.
- Step 9: Group Leader to submit hard & soft copy of the group work to the Member-Director (P&E), BARC and the Convener of the workshop.
- Step10: Group Leaders to finalize the draft report covering outcome of the workshop activities.
- Tips: To determine the research agenda, identify the problems and analyze each in respect of magnitude, urgency, success probability, volume of beneficiary and anticipated adoption by the users

Sub-sectoral Studies: List of Group Leaders and Member-Secretaries

Sl. No.	Sector/ Sub-sector	Areas to be covered (but not limited to)	Group Leader	Member-Secretary
1.	Cereals: Rice	Improvement of Rice varieties, Disease and Pest Management, Crop Adaptation to Climate Change, Biotechnology, Coastal Agriculture, Drought, Management, etc.	Dr. Md. Nasir Uddin, Ex-Director (Research), BRRI.	Dr. Mian Sayeed Hassan, PSO (Crops), BARC
2.	Non-Rice Cereals, Sugarcane, and Jute	Cereal Crops Improvement, Disease and Pest Management Crop Adaptation to Climate Change, Biotechnology, Coastal Agriculture, Drought, Management, etc.	Dr. M. Motiur Rahman, Ex-Director general, BARI	Dr. Md. Rafiqul Islam Mondal CSO (Crops), BARC.
3.	Horticultural Crops: Fruits, Vegetables, Spices, Flowers and Potato	Crops Improvement, Disease and Pest Management Crop Adaptation to Climate Change, Biotechnology, Coastal Agriculture, Propagation Technique, Hill Agriculture, etc.	Prof. Dr. Md. Abdus Siddque Dept. of Horticulture, BAU, Mymensingh	Dr. Abul Kalam, Azad CSO (Crops), BARC
4.	Pulses and Oil Crops	Crops Improvement, Disease and Pest Management Crop Adaptation to Climate Change, Biotechnology, Coastal Agriculture, Drought, Management, etc.	Prof. Dr. Md. Lutfur Rahman Dept. of Genetics and Plant Breeding, BAU, Mymensingh	Dr. Md. Aziz Zilani Chowdhury, PSO (Crops), BARC
5.	Land and Soil Resource Management	Soil Quality, Nutrient Status, Soil Health, Land Management & Degradation, Fertilizer Use Efficiency, Coastal Soil Management, etc.	Prof. Dr. Md. Jahiruddin Dept. of Soil Science, BAU, Mymensingh	Dr. M. A. Satter, CSO (Soils), BARC
6.	Forestry	Nursery Management, Disease and Pest Management, Agro-forestry, Climate Change, Afforestation in hilly and Coastal regions,	Mr. Fariduddin Ahmed, Executive Director, Arannyak Foundation, Banani, Dhaka	Dr. Mohammad Shahjahan, CSO (Forestry), BARC

Sl. No.	Sector/ Sub-sector	Areas to be covered (but not limited to)	Group Leader	Member-Secretary
		Medicinal Plants, etc.		
7.	Livestock	Epidemiology & Surveillance of diseases, Developments of Vaccines, Zoonotic diseases, Breed development and testing, Conservation of endangered species, Feed, Nutrition & Marine Fishery, Aquatic Pollution, Conservation of endangered species, etc.	Prof. Dr. M. M. Tarek, Former Professor, Department of Animal Nutrition, BAU, Mymensingh	Dr. Shah Md. Ziqrul Haq Chowdhury, CSO (Livestock), BARC
8.	Fisheries	Integrated farming, Intensification of fish culture & management technologies, Quality feed development, Fresh water & Marine Fishery, Aquatic Pollution, Conservation of endangered species, etc.	Dr. Khabir Ahmed, Former Executive Chairman, BARC	Dr. Md. Kabir Ikramul Haque, CSO (Livestock), BARC
9.	Irrigation & Water Management, Farm Machinery and Post-harvest Technology (Engineering Aspects)	Design & Development of low-cost farm machineries, Post-harvest Equipment, Water Management/Efficiency, Water quality, etc.	Prof. Dr. A T M Ziauddin, Dept. of FPM BAU, Mymensingh	Dr. Sultan Ahmed, CSO (Agril. Engg), BARC
10.	ICT and Disaster Management in Agriculture	Agricultural Databases & Knowledge Management, Use of GIS & Remote Sensing, Use of ICT in Vulnerable Environmental Monitoring etc.	Dr. SK. Ghulam Hussain, Member-Director, BARC	Mr. Md. Abeer Hossain Chowdhury, Director (Computer), BARC
11.	Agricultural Economics, Marketing and Supply Chain Development	Yield gap minimization, Profitability, Return over investment, Economics of Irrigation and Water Management, Impact Assessment of different technologies and projects, Public Intervention, Agricultural Price Policy & farm support, Land use	Dr. Md. Abul Quasem, Former Senior Research Fellow, BIDS	Dr. Fauzia Yasmin, PSO (AERS), BARC

Sl. No.	Sector/ Sub-sector	Areas to be covered (but not limited to)	Group Leader	Member-Secretary
		and Land resource management etc.		
12.	Food Availability and Consumption, Post-harvest Losses, Agro-processing Technology, Food Safety and Human Nutrition	Agri-business & Agro-processing, Post-harvest Handling, Food Adulteration, etc.	Mr. Md. Abul Quddus, Former Director General, BARD & WFP Adviser, Dhaka	Dr. M. Moslem Uddin Mia, Director (Nutrition), BARC

List of Participant Group Members Meeting, Date: 15.12.2009

Sl. No.	Name	Designation & Address
1.	Dr. Md. Nasiruddin	Group Leader
2.	Dr. Mian Sayeed Hassan	PSO (Crops), BARC, Farmgate, Dhaka
3.	Dr. M. A. Taher Mia	CSO & Head, Plant Pathology Division, BRRI, Gazipur.
4.	Dr. M. Shaha Alam	CSO & Head, Ag. Econo. Div., BRRI, Gazipur.
5.	Dr. A. W. Julfikar	Director (Admin), BRRI, Gazipur
6.	Dr. A.K.G. Md. Enamul Haque	CSO & Head, Plant Breeding Division, BRRI, Gazipur.
7.	Md. Akhter Hossain Khan	CSO & Head, RFSD, BRRI, Gazipur
8.	Dr. M. M. Salam	Director (Research), BINA, Mymensingh
9.	Dr. M. A. Rashid	PSO, Irrigation Water Management Division, BRRI, Gazipur.

List of Participants Group Members Meeting, Date: 24.12.2009

Sl. No.	Name	Designation & Address
1.	Dr. Md. Nasiruddin	Group Leader
2.	Dr. Mian Sayeed Hassan	PSO (Crops), BARC, Farmgate, Dhaka
3.	Dr. M. A Khaleque Mian	Prof: Dept. of Genetics and Plant Breeding, BSMRAU, Salna.
4.	Dr. A.K.G. Md. Enamul Haque	CSO & Head, Plant Breeding Division, BRRI, Gazipur.
5.	Dr. M. A. Rashid	PSO, Irrigation Water Management Division, BRRI, Gazipur.
6.	Dr. Md. Syedul Islam	CSO, FMPHT Division, BRRI, Gazipur
7.	Dr. Md. Humayun Kabir	PSO, ARD Division, BRRI, Gazipur
8.	Dr. K.P. Halder	PSO, Farm Management Division, BRRI, Gazipur.
9.	Dr. Md. Rafiqul Islam	PSO, Agril Econo. Division, BRRI, Gazipur
10.	Dr. M. A. Taher Mia	CSO & Head, Plant Pathology Division, BRRI, Gazipur.
11.	Md. Akhter Hossain Khan	CSO & Head, RFSD, BRRI, Gazipur

Comments on the draft report by the experts in a workshop held on 8th March 2010 at BARC

Key points of the discussion/guidelines by the expert scientists/officers participated in the discussion are as follows: (Translated from Bengali)

Dr. Md. Saifuzzaman, former PSO, WRC, BARI, Gazipur

- Yield may be reduced if short duration varieties are developed,
- Water management issue did not received importance,
- There should be guidelines for future research on biotechnology.

Prof. Dr. Md. Khalek Mia, Plant Breeding Division, BMSRAU, Salna, Gazipur

- Character accumulation should be done through gene mining from genetic resources,
- Gene pyramiding should be considered with due importance for plant breeding.

Dr. Abul kalam Azad, CSO (Crops), BARC

- Genetic Conservation has not been highlighted,
- Comments of supervising experts on the report are urgent.

Prof. Dr. Shahidur Rashid Bhuiyan, Plant Breeding division, SARDI

- More attention are to be paid on deep water aman rice,
- Pyramiding is necessary for gene incorporation of BRRI dhan 28 and BRRI dhan 29,
- Effort to be paid to increase the area of T. Aman rice,
- Short duration variety of rice is needed,
- Is it possible to compete with foreign countries regarding development of hybrid varieties,
- More number of quality breeders needed,
- Programmes on transgenic rice should be incorporated,
- Guidelines on climate change is needed in future research.

Dr. S.M. Monwar Hossain, Executive Director, Hortex Foundation

- Much more nutrient would be required for increasing yield target incase of crop intensification. Therefore, relevant research agenda should be needed,
- Milling loss is a great problem for rice. So, importance to be paid for reducing milling loss,
- There should be programmes on quality issues for rice export in future,
- Works to be done on cropping system research, particularly on soil health.

Prof. Abdul Hamid, Director (Research), KGF, BARC campus, Farmgate, Dhaka

- Much concern on variety development visible in rice, but
- more attention to be paid regarding agronomic management,
- There are observations on yield gap, but there is no research agenda.
- Needs research on improved technologies from foreign countries,
- All institutes should be integrated. Expertise of Social and Economic division of BAU may be used,
- Jhum cultivation can not be stopped overnight. Sticky rice varieties to be developed.
- Not only sea level rise; issues like flood, drought etc., also shall receive importance with respect to climate change.
- Research should be prioritized through identifying yield gap.

Dr. Sk. Gulam Hussain, Member-Director (P&E), BARC, Farmgate, Dhaka

- Issues mentioned under ICT in Agriculture are not consistent at all. There is no research agenda in this sub-sector.

Dr. Md. Abdus Salam, Director (Research), BINNA, Mymensingh

- Research Achievement of BINA is not highlighted. It needs to be incorporated and the achievement of BINA is submitted herewith.

Dr. Md. Deloar Hossain, CSO, Plant Pathology division, BARI, Gazipur

- Short duration varieties, particularly of T. Aman, are much needed,
- Varieties on boro rice with late planting potential are to be developed.

Dr. Khairul Bashar, CSO, GRS division, BRRI, Gazipur

- High input-high output varieties to be developed,
- Rice knowledge bank (ICT) to be developed.

Mr. Akhter Hossain Khan, Ex CSO, RFS division, BRRI

- There shall be own safety for own research, particularly for hybrid development,
- Importance shall be paid to system research.

Dr. A.N.M. Oliullah, Deputy Director, DAE, Dhaka

- Issues on crop zoning to be highlighted,
- Importance shall be paid to develop water saving/ urea saving technologies.

Dr. Md. Khalequzzaman Akand Chowdhury, Membr-Director (Crops), BARC

- Importance shall be paid on water saving (Alternate Wet and Dry) technologies,
- Low input high output varieties shall be developed,

Dr. Wais Kabir, Executive Chairman, BARC, Farmgate, Dhaka

- Situation analysis should be performed properly,
- Methods should be mentioned,
- Might be mentioned the type of supports needed.
- SWOT analysis should be done,
- Input supply system should be formulated in such a way that it supports the present cultivation system,
- Areas of regional/ international collaboration should be identified. Specific areas of collaboration are to be mentioned.

Comments of Dr. Md. Nasiruddin, Former Director (Research), BRRI

1. The sectoral study to provide vision for the year '2030 and beyond'. This to be based on the problem, opportunities, with a clear reflection of the country's situation, demand supply side etc. and then to please come up with the areas of research along with the priority. This to be supported by the priority matrix provided earlier (Ref. ToR on this particular issue plus others).
2. Regional workshop recommendations to be taken into account.
3. What about International Collaboration? In particular with the CGIAR institutions.
4. Suggested /circulated Report content to be followed.
5. In all cases wherever available BBS data to be used. For others, source to be quoted

Comments from the learned participants:

1. Water scarcity issue to be dealt further. What about aerobic rice?
2. Genetic resource conservation & management should get importance.
3. Stress on deepwater rice development: as with predicted climate change there will be more inundation.
4. Plant Breeder can't be a beneficiary.
5. Not much scope for hybrid Rice development perhaps. As lot of varieties of Hybrid are coming from outside.
6. Loss at the post-harvest stage: how best we can handle it?
7. Rice based pattern to accommodate other crops e.g. leguminous one -for productivity as well as to maintain soil health.
8. Yield gap issue to be in the text (not only in recommendation part, with research reference and by region (Mr. Akhter has got report on the subject).
9. Regional workshop recommendations to be taken into account. Here 'Jhum'-rice cultivation and its improvement as stressed in the Chittagong-CHT workshop may be pointed as an example.
10. Management issues in rice cultivation to be given priority.
11. Role of ICT as stated in the recommendations to be more focused.

12. BINA's work (as referred by Dr. Salam of BINA) to be incorporated in the report.
13. Stress on high input- high output plus low input- high output variety development.
14. More stress on the development of short duration T. Aman & Boro.
15. Research program/issues may be furnished as a list- not by institutions. What about BAU, BINA's work?

**Workshop on Problem Identification and Priority Setting Group
No. 2 Coastal Agriculture (Non-Saline)**

1. Development of bold grain short duration boro rice variety for Barisal region
2. Development of short duration tall HYV T. Aman rice for southern region

1. Development of more Aus rice varieties resistant to tidal submergence (south)
2. Development of salt tolerant variety of rice
3. Hybrid rice seed development

1. BPH problem for rice
2. Deep water rice
3. Development of BLB tolerant hybrid rice
4. Short duration and late planting rabi crops should be developed

1. BPH problem for rice
2. Deep water rice variety development
3. BLB problem in rice
4. Short duration and late planting rabi crop varieties (Pulses, oilseeds, tomato & wheat) should be developed
5. Development of suitable technologies/cropping pattern for fallow land during rabi and kharif-1

1. Development of determinate type of mungbean variety
2. Virus resistant varieties (mungbean, papaya, ladies finger and country bean)
3. suitable variety of kheshari for relay cropping
4. quality seeds and retting problems of jute
5. Short duration oilseeds, cotton, sunflower and soybean
6. Water logging problem due to Kopatakho river

1. Establishment of Cold storage at southern region
2. Foot rot of lentil and chickpea
3. Trips and pod borer for mungbean
4. Wilt of water melon
5. Draw down of ground water
6. Declining organic mater
7. Anthracnose of litchi and mango and hopper problem in mango
8. Root and fruit rot of brinjal
9. Preservation of fruit, vegetable and flower

1. Research should be undertaken on dieback of betel nut and anthracnose of guava
2. Development of short duration and water submergence tolerant variety of sesame
3. Short duration of jute variety
4. Low yield of coconut due to mites
5. Research should be undertaken on vegetables and fruit in the *Gher*
6. Un-controlled expansion of tobacco

1. Irrigation facilities through ground water and surface water should be developed
2. Agricultural mechanization should be developed
3. Processing and marketing facilities of guava, vegetable, hog plum, and potato should be developed
4. Crop zoning

1. Research and Development should be strengthened in Sugarcane, date and palmyra palm (tal) in this region
2. Lack of marketing facilities of maize

Workshop on Problem Identification and Priority Setting Group No.2 Coastal Agriculture (Saline)

Problem Analysis				
Sl No.	Type of Problem	Magnitude (% of total Area)	Severity of the problem	Priority ranking
1.	Soil and water salinity in dry season (november-april e.g. lack of reservoir for sweet water/rain water conservation)	50	1	High
2.	Heavy consistency and silty clay soil (crackdown of upper soil)		2	
3.	Scarcity of sweat water in dry season for irrigation		1	
4.	Unplanned shrimp culture		2	
5.	Less natural high land for vegetable and fruit cultivation		2	
6.	Unavailability of salt, drought and heat tolerant variety of existing crops, vegetable		1	
7.	Cold injury to boro seedling growth and lesser rabi crop production		3	
8.	Short winter retards production of rabi crops like lentil.		2	
9.	Water stagnant for T. Aman in shatkira, khulna, bagerhat		1	
10.	Salinity affect on vegetables, fruits and forests.			
11.	Degradation of soil chemical, physical (crack soil) and biological properties			
12.	Lack of fodder crops			
13.	Damage of T. Aman seedling by tidal water			
14.	Lack of submergence tolerant and having characteristics of taller seedling of t.aman variety			
15.	Increase of extant and seventy of salinity area due to damaged embankment			
16.	Unavailable storage and marketing facility for			

Problem Analysis				
Sl No.	Type of Problem	Magnitude (% of total Area)	Severity of the problem	Priority ranking
	perishable crops			
17	Insufficient number of research stations for coastal saline area			
18	Lack of appropriate production package for existing crops			

Policy Issues:

- Land tenure system
- Poor management of sluice gates
- Poor linkage among research-extension-education system
- Development of forecasting facility for seasonal soil and water salinity

Workshop on Agricultural Priority Setting held at Bogra on 29 December 2009

Problem Specification	Location where the Problem exists	Magnitude of the problem	Extent of severity (1-10 scale, 10 being highest)	Ranking
Depletion of organic matter	Rangpur	Rangpur	8	H
Wheat varieties suitable for late planting	Do	Do	9	H
Short duration T.Aman rice variety to replace Swarna	Do	Do	9	H
Development of improved mungbean varieties suitable for cultivation after wheat	Do	Do	8	H
Research on sheath blight	Do	Do	7	M

Problem Specification	Location where the Problem exists	Magnitude of the problem	Extent of severity (1-10 scale, 10 being highest)	Ranking
of rice				
Research on BPH problem and control measure	Do	Do	7	M
Research on mite of chili	Do	Do	7	M
Shade tolerant rice variety	Do	Do	6	M
Research on wilting of brinjal	Do	Do	6	M
Development of short duration lentil	Do	Do	8	H
Soil degradation due to herbicide use	Do	Do	5	L
Research on bio-herbicide for rice	Do	Do	6	M
Research on forced maturing of banana, tomato, mango and papaya using chemicals	Do	Do	7	M
Pesticides residues in food chain	Do	Do	9	H
Toxicity duration of pesticides	Do	Do	8	H
Development of high yielding summer shim	Do	Do	7	M
Virus in summer tomato	Do	Do	7	M
Low yield in lentil	Do	Do	7	M
Short high Yielding cotton variety	Do	Do	7	M
Hybrid cotton	Do	Do	8	M
Intercropping with cotton	Do	Do	7	M
Cotton by-products to be used mushroom media	Do	Do	7	M
Drawdown of water table	Dinajpur	Dinajpur	7	M
Micronutrient deficiency – brinjal, cole crops, potato	Do	Do	7	M
Development of drought tolerant crop varieties for Barind	Do	Do		

Problem Specification	Location where the Problem exists	Magnitude of the problem	Extent of severity (1-10 scale, 10 being highest)	Ranking
Alternate bearing of mango decreases productivity	Do	Do	7	M
Flower and fruit dropping of mango	Do	Do	9	H
Fruit borer, stem borer, powdery mildew of jujube (BAU jujubi & Apel jujubi)	Do	Do	8	H
Less or no bearing of fruits in cucurbits	Do	Do	7	M
Coconut fruit cracking (mites or drought)	Do	Do	7	M
Bottle gourd (black spot)	Do	Do	8	H
Inappropriate cropping patterns leads to soil mining, reduced cropping intensity	Do	Do	7	M
Fe & As problem in irrigation water	Gaibandha	Gaibandha	9	H
Fungal and bacterial problem in potato	Do	Do	8	H
Cracking of cabbage	Do	Do	8	H
Heat tolerant variety of wheat	Do	Do	9	H
Rapid soil testing kit	Do	Do	7	M
Reduction of water bodies leading to loss of surface water for irrigation	Pabna & Sirajganj	Pabna & Sirajganj	8	H
Loss of prime cropped land due to urbanization and industrialization	Do	Do	8	H
River erosion and siltation of cropped land	Do	Do	8	H
Water logging due to inappropriate infrastructure development	Do	Do	8	H
Improved crops and	Do	Do	8	H

Problem Specification	Location where the Problem exists	Magnitude of the problem	Extent of severity (1-10 scale, 10 being highest)	Ranking
varieties for charland				
BPH in Boro and T.Aman rice	Do	Do	7	M
Insect pest (cut worm) of mustard	Do	Do	7	M
Inclusion of legumes in cropping system	Do	Do	7	M
Development of the technology of quality jute seed production	Do	Do	8	H
Lowering water table	Rajshahi & C. Nawabganj	Rajshahi & C.Nawabganj	8	H
Water scarcity for irrigation	Do	Do	8	M
Transformation of riceland to other crops	Do	Do	7	M
Dieback and gummosis in mango	Do	Do	9	H
Foot rot and stem rot in betel vine	Do	Do	8	H
Development of no-tillage technology	Do	Do	7	M
Research on the causes of wheat yield reduction			8	H
Research on yield decline in Apel kul	Do	Do	7	M
Development of harvester for rice	Do	Do	8	H
Causes of lowering water table	Do	Do	7	M
Mango insecticides affect sericulture	Do	Do	6	M
Marketing of sericulture product	Do	Do	7	M
Resistance of potato pests to insecticide	Bogra & Naogaon	Bogra & Naogaon	7	M
Research on chili diseases	Do	Do	7	M
Off-season vegetables –	Do	Do	7	M

Problem Specification	Location where the Problem exists	Magnitude of the problem	Extent of severity (1-10 scale, 10 being highest)	Ranking
inputs easy availability				
Onion- thrips to be controlled	Do	Do	9	H
Improved variety of onion	Do	Do	9	H
Submergence tolerant/deep water rice (modern varieties)	Do	Do	9	H
Sort duration modern T. Aman rice variety to be developed	Do	Do	9	H
Standardization of growth hormone for different crops	Do	Do	8	M
Shrim- marketing problem	Do	Do	7	M
Development of gynoceous vegetables for female flower induction	Do	Do	8	M
Variable phenotypes in same hybrid. Test of hybrid is required	Do	Do	8	H
Improving onion varieties (including Tahirpuri)	Do	Do	9	H
Development of hybrid cauliflower variety	Do	Do	8	H
Photo-insensitive varieties of cucurbits	Do	Do	8	H
Short duration varieties of sponge gourd	Do	Do	7	M
Transferring salinity drought resistance genes to cucurbits	Do	Do	8	M

Note: H=High, M=Medium and L=Low

Chittagong-Crops (Hill Agriculture)

SI No.	Problem Specification	Location where the Problem exists	Magnitude of the problem (example, area affected, ha)	Extent of severity (1-10 scale, 10 being highest)	Ranking
1	Jhum cultivation	CHT	CHT		
	(i) Improvement of indigenous rice variety	Do	Do	8	
	(ii) Lack of improved management practices for Jhum cultivation	Do	Do		H
2.	Scarcity of irrigation water during dry season	Do	Do	8	H
3.	Soil fertility Problems:	Do	Do	8	H
	(i) Control of soil erosion	Do	Do		
	(ii) Soil management for improving soil organic management	Do	Do		
	(iii) Alleviating soil acidity	Do	Do		
4.	Lack of proper marketing facility:	Do	Do	7	
	i) Establishment of processing industry	Do	Do	7	
	ii) Development of storage facilities	Do	Do	7	
	iii) Improvement of transport facilities	Do	Do	7	M
5.	Development of quality seeds and saplings of fruits and vegetables	Do	Do	7	M
6.	Extinction of plant species: Local fruits and vegetables.	Do	Do	7	M

Sl No.	Problem Specification	Location where the Problem exists	Magnitude of the problem (example, ha)	Extent of severity (1-10 scale, 10 being highest)	Ranking
	Moisture conserving Crops e.g. Tara/Katal denghi				
7	Indiscriminate use of chemicals (pesticides, hormones, and vitamins).	Do	Do	7	M
8	Planting techniques- close planting, deep planting, etc.	Do	Do	7	M
9	Disease management – rhizome rot of ginger and turmeric	Do	Do	7	M
10	Cotton:	Do	Do	8	M
	Introduction of American cotton for higher yield	Do	Do		
	Establishing ginning factory	Do	Do		

Crops (Costal Agriculture), Chittagong Region

Problem Specification	Location where the problem exists	Magnitude of the problem (example, area affected, ha)	Extent of severity (1-10 scale, 10 being highest)	Ranking H, M or L
Changes of cropping pattern in saline area.	Saline areas of the region	Saline areas of the region	9	H
Suitable rice variety development for saline areas	Do	Do	9	H
Drought resistant variety introduction of felon	Do	Do	8	H
Introduction of pest resistant variety of bean at Sitakunda	Do	Do	8	H
Revive of water melon of Patenga by tissue culture	Do	Do	8	H
Development of disease resistant variety specially soft rot of zinger	Do	Do	8	H
Tissue culture of year round var. of jackfruit	Do	Do	7	M
Removal of seasonal water logging in low lying area (adaptive research)	Do	Do	7	M
Introduction of mite resistant Variety in Taro	Do	Do	7	M

Problem Specification	Location where the problem exists	Magnitude of the problem (example, area affected, ha)	Extent of severity (1-10 scale, 10 being highest)	Ranking H, M or L
Stem rot problem of groundnut, felon, pea and other leguminous crops	Do	Do	8	H
Development of wheat variety for saline area	Do	Do	9	H
Zinger, turmeric variety against rot disease	Do	Do	9	H
Elephant problem in plain land	Do	Do	8	M
Development of short duration variety for Aus and T. Aman for Noakhali & Feni	Do	Do	8	M
Blast problem of BR29 in water logging area.	Do	Do	8	M
Pod borer problem for soybean & lady's finger	Do	Do	9	H
Replacement of rein tree in homestead	Do	Do	6	M
Cultivation of sunflower as ail crop	Do	Do	7	M
Development of salt tolerant variety of Onion	Do	Do	8	H
To test the Salinity status of released hybrid variety	Do	Do	7	M
Development of salinity testing kit	Do	Do	7	M

Crops (Plain Land agriculture)

Problem Specification	Location where the problem exists	Magnitude of the problem (example, area affected, ha)	Extent of severity (1-10 scale, 10 being highest)	Ranking H, M or L
Short durated HYV rice	Chittagong and Sylhet division	Chittagong and Sylhet division	9	H
Hybrid rice with inbreed character	Do	Do	8	M
Heat tolerant with short donatives wheat variety	Do	Do	9	H
Virus and wilt tolerant tomato brinjal	Do	Do	9	H
Research on maize corn borer	Do	Do	7	M
Development of high yielding zinger and turmeric variety	Do	Do	7	M
Research on higher yield of betel leaf	Do	Do	7	M
Development of production technology of hogla and cane	Do	Do	7	M
Development of short duration hyv mustard	Do	Do	8	H
Development of usg applicator and other machineries	Do	Do	8	H
Proper dose of quick compost and usg	Do	Do	7	M
Development of technology of oil palm & grapes	Do	Do	6	M
Scarcity of surface water	Do	Do	7	H

Note: H=High, M=Medium and L=Low

Policy:

1. Activate -ATC Through BARC
2. To Project Agri-Land
3. Soil Health
4. Right Plant right place.

Workshop on Problems Identification and Priority Setting

Group 1. Plain Land Agriculture (Mymensingh region)

Type of Problem	Magnitude (% of the total area/ coverage)	Severity of the problem (1-3)	Expected beneficiary on solving the problem (%)	Priority Ranking (High/Med. /Low)
Depletion of soil fertility & OM, emergence of new nutrient deficiency e.g., Mg, B, etc.	100	1	95	H
Inadequate production of quality seed	80	2	75	M
Lack of cold, heat, insects, diseases, water-logging and drought tolerant varieties of major crops	90	1	85	H
Lack of nutritionally improved varieties of food crops	60	3	50	L
Lack of use of improved biofertilizer and biopesticides	70	2	65	M
Rice based crop diversification	70	2	65	M
Composting of city, domestic & industrial wastes	75	2	60	M
Post-harvest loss of vegetables & fruits, their storage & marketing	80	2	75	M
Mechanization in different practices of crop production	85	2	75	M
Lack of efficient char land management	90	1	85	H

Type of Problem	Magnitude (% of the total area/ coverage)	Severity of the problem (1-3)	Expected beneficiary on solving the problem (%)	Priority Ranking (High/Med. /Low)
Insect and disease infestation of major crops	80	2	75	M
Heavy metal pollution of soil and water from pharmaceutical industries, tanneries, adulterated fertilizers	85	2	80	M
Policies				
Unplanned land utilization	100	1	100	H
Inefficient market channel	85	2	80	M
Introduction of contract farming system for vegetables & high value crops	70	3	65	L
Over use of irrigation water on boro rice cultivation	80	2	75	M
Formulation of field and seed standard for major crops	80	2	75	M
Lack of use of balanced fertilizer	85	2	80	M
Lack of technology/pattern for Ekti Bari Ekti Khamar	100	1	95	H

Group 2. Forests, Hill and Terrace Land Agriculture

Type of problem	Magnitude (% of the total area/coverage)	Severity of the problem (1-3)	Expected beneficiary (%)	Priority Ranking (High/Medium/Low)
1. Water scarcity due to irrigation in piedmont plain	100	1	90	High
2. Soil erosion	50	1	50	High
3. Siltation due to occurrence of flash flood	20	2	70	Medium
4. Droughtiness in the dry season	50-60	1	90	High
5. Deforestation	50	1	50	High
6. Deterioration of soil health	95	1	90	High
7. Problem of marketing facilities	55	2	60	Medium
8. Lack of storage facilities	65	1	80	High
9. Encroachment in the reserved forest	50	2	60	Medium
10. Indiscriminate use of pesticides	100	2	60	High
11. Lack of land zoning	50	2	50	Medium
12. No trans boundary water shed management	30	2	20	Low
13. Lack of effective farmers institutions	20	3	45	Medium
14. Industrial waste management	50	2	50	Medium
15. Lack of public private partnership	40	2	50	Medium
16. Disease & insects infestation in jackfruit trees	50	1	100	High
17. Rhizome rot of ginger	30	2	40	Medium
18. Lack of labour	50	1	60	Medium

Group 3. Region/District: Kishoreganj, Netrokona

Sl. No.	Type of problems	Magnitude (%) of the total areas (%)	Severity of problem (%)	Expected beneficiary (%)	Priority Ranking
1.	Submergence (Development of new varieties)	80	1	90	H
2.	Development of short duration boro rice varieties	90	1	80	High
3.	Development of photo sensitive short duration T.Aman varieties	30	1	50	High
4.	KAP studies	70	1	90	H
5.	Lack of short duration mustard and pulse varieties	30	2	40	M
6.	Flash flood	90	1	100	H
7.	Lack of location specific quick early warning dissemination system on agrometeorology	100	1	100	H
8.	Low fertility in charland	10	3	10	Low
9.	Marketing problem	80	1	80	H
10.	Pest management	80	1	90	H
11.	Drought problem	20	3	30	L
12.	Cold injury	90	1	90	H

Sl. No.	Type of problems	Magnitude (%) of the total areas (%)	Severity of problem (%)	Expected beneficiary (%)	Priority Ranking
13.	Mechanization for rice transplanting and harvesting	100	1	100	H
14.	Lack of suitable vegetable varieties	70	3	70	L
15.	Lack of feed during monsoon of livestock	80	1	90	H
16.	Generation and adaptation of open water fisheries technologies	75	1	80	H
17.	Adaptation of improved poultry birds (layer, ducks, broiler, pegin, etc.)	80	1	90	H
18.	Development of improved raring and management of ruminants	60	2	70	M
19.	Study on role of infrastructure and development agencies in haor areas	60	2	75	M
20.	Possibilities of crop diversification and intensification	90	1	95	H

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